

AVERP2987US

**Title: REAR PROJECTION SCREENS AND LIGHT FILTERS WITH
CONFORMABLE COATINGS AND METHODS OF MAKING THE SAME**

Field of the Invention

1 The invention relates to rear projection screens and light filters,
specifically those with a conformable coating over transparent microspheres.

Background of the Invention

6 Rear projection screens transmit an image from the back of the screen to
the viewer on the opposite side of the screen. The image is affected by the
amount of light transmitted by the screen or filter or throughput. Generally,
screens and filters have been limited by their construction to the amount of light
transmitted through the screen or filter. It is desirable to have constructions
which provide increased light throughput.

11 Generally, rear projection screens have suffered from poor angularity.
Angularity is the term used to describe the ability of a viewer to see a good
image from the screen or filter at some angles other than those which are
ordinary to the screen surface. As the viewer moves to the side of the screen
or filter, the image quality is decreased. It is desirable to have screens and
16 filters which have improved angularity.

 U.S. Patents 5,563,738 and 5,781,344, (Vance), relate to light
transmitting and dispersing filters having low reflectance. The multi-layer light
filters use the addition of optical layers to a basic refractive light filter to allow
adjustment of gain, contrast and ambient light rejection of light filters.

21 U.S. Patent 6,076,933 (DiLoreto et al) describes light transmitting and
dispersing filters similar to those described by Vance with the addition of a

1 conformal layer of light transmissive material on the back surface of the transparent beads.

Rear projection screens typically contain mechanisms such as minute colloidal particles to diffuse the light into the desired viewing space. When these screens are used with high magnification systems in which the projection beam is nearly coherent, an undesirable artifact in the form of a speckle pattern (e.g., bright pin holes) often is observed. The speckle pattern is most pronounced in screens with high gains. Speckle reduction has been discussed in the literature. It is known for example that to reduce the visibility of speckle, the coherence of the illumination beam must be destroyed. One method which has been suggested is to move one diffusion screen with respect to another and separating the diffusing surfaces. When modifying the screens to reduce speckle, however, it is important not to deteriorate the resolution on the screen.

Summary of the Invention

16 This invention relates to light transmitting filters comprising:

(a) a light absorbing layer of material having a front surface and a back surface,

(b) transparent microspheres embedded in the light absorbing layer and contacting the front surface of the light absorbing layer with portions of the microspheres protruding through the back surface of the light absorbing layer for transmitting light through the light absorbing layer, and

(c) a conformed layer of optically clear material having a front surface and a back surface wherein the front surface of the conformed layer is in contact with and conforming in shape with the protruding portions of the microspheres, and wherein the back surface of the conformed layer has a textured finish.

1 a) a light absorbing layer of material having a front surface and
a back surface,

 (b) transparent microspheres embedded in the light absorbing
layer and contacting the front surface of the light absorbing layer with portions
of the microspheres protruding through the back surface of the light absorbing
6 layer whereby the microspheres transmit light through the light absorbing layer,
and

 (c) a conformed layer of optically clear material having a front
surface and a back surface wherein the front surface of the conformable layer
is in contact with and conforming in shape with the protruding portions of the
11 microspheres, and wherein the back surface of the conformable layer has a
textured finish.

 The light absorbing layer serves a number of purposes including fixing the
beads, reducing the reflectivity of the light filter, and reducing the amount of
light transmitted from the back surface through the interstices between the
16 microspheres in the system to the viewer. This layer generally has a thickness
sufficient for embedding the transparent microspheres. The embedding of the
transparent microspheres may be at any level provided that the transparent
microspheres form a light tunnel through the light absorbing layer. In one
embodiment, the light absorbing layer has a thickness from about 10% to 90%,
21 or from about 10% to about 80% of the transparent microsphere diameter. The
light absorbing layer may be any material which is substantially opaque and can
be embedded with the transparent microspheres to form light tunnels through
the opaque layer. The light absorbing layer may be any material which is
malleable enough to yield when the transparent microspheres are pushed
26 against it, such as a partially or incompletely crosslinked urethane, a pressure
sensitive adhesive, or with the addition of heat, thermoplastic polymers. The

1 light absorbing material may also be a material which can form around the
transparent microsphere, such as an asphalt or adhesive (a pigmented pressure
sensitive adhesive).

Typically, the light absorbing layer is a combination of one or more
pigments, usually carbon black, or other colorant, and one or more polymers,
6 such as polyolefins, polyacrylates, polyvinyl acetals such as polyvinyl butyral,
(e.g., Butvar resins available from Solutia), polyurethanes, polyesters or
polyvinylcarboxylates. The polyolefins may be homopolymers and copolymers
of C₂₋₁₂ olefins, such as ethylene, propylene, and butylene. The polyacrylates,
including polymethacrylates, may be homopolymers or copolymer of C₁₋₁₂
11 acrylate or methacrylate monomers, such as methyl, ethyl, propyl, butyl, hexyl,
or octyl acrylates or methacrylates. Here and elsewhere in the specification and
claims, the term for pendant groups is meant to include all isomeric forms of the
group. For instance, the use of the term octyl is intended to cover n-octyl,
isooctyl, and 2-ethylhexyl groups. The polyvinylcarboxylates include homo or
16 copolymers of C₁₋₁₂ vinyl carboxylates, such as vinyl acetate, vinyl propionate
and vinyl butyrate. Examples of useful commercially available polyacrylates
include Acrylic HI-7 from ICI and Acrylic MI-7 from Rohm & Haas. The light
absorbing layer may contain from about 2% to about 10% by weight of the
pigment and/or colorant.

21 Alternatively, the light absorbing layer may be a photosensitive film, in
which case its optical density can be varied by exposure to actinic light.
Photochromic materials which automatically adjust their absorption in response
to ambient light conditions also can be used. In addition to film and polymer
type materials, the light absorbing layer may be a wire mesh or perforated metal
26 sheet, or a combination of wire mesh and polymers.

Transparent microspheres are embedded into the light absorbing layer. Typically the transparent microspheres are embedded to a level sufficient to provide light tunnels through the light absorbing layer. Light tunnels are present when the microspheres are embedded sufficiently into the light absorbing layer so that portions of the microspheres are in contact with, and in some instances, may perforate the front surface of the light absorbing layer, and other portions of the microspheres protrude through the back surface of the light absorbing layer. Generally, the transparent microspheres are embedded at a level of about 10% to about 80%, and in one embodiment, less than about 50% (preferably from about 30% to about 40%) of their diameter. The transparent microspheres generally have a refractive index from about 1.4 to 2.3, or from about 1.4 to about 2.2, or from about 1.45 to about 1.95. They are typically composed of glass, ceramic, plastic or other suitably transparent materials. The microspheres also may be composed of photochromic materials to allow their optical properties to respond to changes in incident light intensity. Alternatively, colored transparent microspheres may be used to allow chromatic effects. Transparent microspheres having an average diameter of from about 25 to about 300 microns are suitable for construction of the light filters described herein. In one embodiment, the transparent microspheres have a diameter of about 30 to about 120, or from about 40 to about 80, or from about 50 to 65 microns. In one embodiment, the diameter is an average diameter. In one embodiment, the transparent microspheres are substantially uniform in size. In another embodiment microspheres of different diameters can be combined in a light filter to increase the packing density. In some embodiments, it may be useful to use microspheres which are non-spherical in shape such as ellipsoids or rounded rods. These non-spherical shapes can be deposited in alignments that provide different optical properties in different

1 directions. In another embodiment, the transparent microspheres are present
in substantially a monolayer generally covering from 60% to about 91% of the
surface area of the back surface light absorbing layer, or from about 75% to
about 90%, or from about 85% to about 90% of the surface area of the back
surface of the light absorbing layer.

6 The microspheres can be embedded in a close-pack array using a number
of well known processes. In one method, a removable support material such
as paper or a polymer film is coated with a thermoplastic resin binder layer
which is modified by colorant to adjust the binder layer to the desired opacity.
11 Microspheres are then spread over the resin binder layer which is subsequently
heated, allowing the microspheres to be pressed into the resin binder layer until
the microspheres contact the surface of the support material. The microspheres
may be also deposited by electrophoresis from a fluid medium by spraying a
mixture of microspheres, material for the binder layer and a solvent onto a
support material, or by spraying microspheres directly onto a softened resin
16 binder layer.

Another component of the light transmitting filter is the optically clear
conformed layer. In one embodiment the conformed layer is substantially
uniform in thickness. This layer typically has a thickness of about 10% to
about 90% of the diameter of the average microsphere, or from about 20% to
21 about 80%, or from about 30% to about 70% of the diameter of the average
microsphere. In one embodiment, the conformed layer has an average thickness
of from about 2.5 microns to about 270 microns. In another embodiment the
thickness is from about 7.5 microns to about 75 microns. The conformed layer
comprises any polymer which has the optical clarity needed for light
26 transmitting filters. Typically these polymers are polyolefins, such as optically
clear polyolefins from metallocene catalysts, polyacrylates, polymethacrylates,

1 polycarbonates, polyurethanes, polyesters, such as polyethylene terephthates,
polyvinylidene dichloride, cellophane, cellulose acetate, polyvinylidene
difluorides, polyvinyl chlorides, polyvinyl acetals, and polyvinylcarboxylates.
The front surface of the conformed layer is adhered to the back surface of the
light absorbing layer and the microspheres which protrude from the back surface
6 of the light absorbing layer.

In one embodiment, the light filter may have a tie layer to improve the
adhesion of the conformed coating to the transparent microspheres and the
light absorbing layer. This may be any material which improves this adhesion.
Examples of suitable tie layer resins include "Platamid", available from Elf
11 Atochem, "CXA", available from DuPont, and "Plexar" available from Chemplex.
In another embodiment, the transparent microspheres and the light absorbing
layer may be corona treated to improve the adhesion to the front surface of the
conformed optically clear coating.

As noted above, the back surface of the conformed layer of optically clear
16 material has a textured finish which results in reduced speckling. It is believed
that the textured finish scatters reflected light with minimal effect on total light
transmission thereby reducing speckling. In one embodiment, the textured
finish may be a random microstructured surface such as a matte finish, or the
finish may contain a pattern of three-dimensional microstructures having cross
21 sections made up of very small circles, ovals, diamonds, squares, rectangles,
triangles, polygons, lines, or irregular shapes when the cross section is taken
parallel to the surface of the light absorbing material. The textured finish can
be, in some instances, a holographic image embossed into the surface of the
film. Several procedures and techniques are known to those skilled in the art
26 for producing textured finishes on surfaces which can be used to form the
textured finish on the back surface of the conformed layer. For example, the

back surface of a conformable layer of optically clear material may be textured, prior to being conformed to the microspheres, by contact with a film or paper having a textured or matte finish. The finish on the film is replicated on the surface of the conformable layer when the two surfaces are joined by pressure. Alternatively the desired surface of the conformable layer deposited on, e.g., a release liner, can be textured by passing the construction through heated rollers, at least one of which has a textured surface. In another method, the image can be imparted to the back surface of the conformed layer by first printing an image or textured surface onto the face of a polymer coated surface of a casting sheet. The printing can be done using common printing techniques such as Flexography (Flexo) and Rotogravure (gravure). Heat and pressure are used to press the image into the face of the polymer coated casting sheet so that the top of the print is substantially level with the polymer coated surface. The conformable layer is then applied over the textured surface such as by lamination thereby replicating the textured or printed surface on the back surface of the conformable layer.

The conformed layer of optically clear material in one embodiment comprises a substantially uniform layer which has a thickness with little variance, such as a variation in thickness of less than about 10 microns, or even less than about 2.5 microns or even less than 1.25 microns. The conformed layer conforms substantially in shape to the protruding microspheres in the light absorbing layer. Thus, the conformed layer of optically clear material defines a plurality of lenses which are disposed on the back surface of a corresponding one of the microspheres and has a substantially spherical back surface with a radius of curvature somewhat larger than the radius of curvature of the microsphere.

1 The microspheres which protrude from the back surface of the light
absorbing layer have a center of curvature, and the back surface of the
conformed layer has a center of curvature. In one embodiment the center of
curvature of the back surface of the conformed layer of optically clear material
is behind the center of curvature of the microspheres, and this increases
6 convergence of the light into the microspheres. In another embodiment, the
center of curvature of the back surface of the conformed layer is about equal
to the center of curvature of the microspheres thereby increasing convergences
of light into the microspheres.

11 The conformed layer of optically clear material provides a preliminary
stage of convergence of the light into the microspheres. Also, it is believed that
positioning the centers of curvature of the back surface of the conformed layer
behind the centers of curvature of the microspheres increases convergence of
such light into the beads, and converges the light nearer the ideal angles for
refraction of the light through the transmission areas in front of the
16 microspheres.

21 In one embodiment, the front surface of the light absorbing layer may be
supported by a an optically clear support layer to improve the sturdiness of the
filter. The optically clear support layer may be a glass or a polymer. The
support layer must resist the pressure exerted by the transparent microspheres
during the embedding and conforming processes. The support layer may be
adhered to the light absorbing layer by an adhesive, by lamination, or as a result
of coextrusion. The support layer may be any material having sufficient
strength to provide support to the light absorbing layer and having optically clear
characteristics. Examples of support layers include glass, polyacrylics,

1 polycarbonates, polyurethanes, such as two part polyurethanes, polyesters,
such as polyethylene terephthalates, and any of the materials described above
as useful in the conformed layer of optically clear materials.

The methods of making the light transmitting filters may be through heat
lamination. In one embodiment it is desirable that a substantially uniform
6 conformable layer is formed on the transparent microspheres. In one
embodiment, it is desirable that the Vicat softening point of the polymer of the
conformable layer is higher than the Vicat softening point of the polymer of the
molding layer. The molding layer is in contact with the conformable polymeric
layer during preparation of the light filter. The molding layer may be any
11 thermoplastic polymer with the appropriate Vicat softening point. If the molding
layer is composed of a polymer of similar nature to the conformable layer then
a layer of silicone release layer, such as those used for pressure sensitive
adhesive liners, may be used to enhance ease of separation of the layers. In
one embodiment, the molding layer is composed of polyolefins, such as low,
16 medium and high density polyethylene, propylene or mixtures thereof. The
lower Vicat softening point of the molding layers helps form the conformable
layer by softening and/or melting to conform to the surface of the transparent
microspheres. Under the pressure and temperature of preparation, the molding
layer presses the conformable layer against the transparent microspheres.

21 In one embodiment, the light filters of the invention can be prepared by
the steps of (1) providing a first assembly comprising a light absorbing layer
having a front surface and a back surface wherein the front surface is adhered
to a removable substrate, and a monolayer of transparent microspheres
embedded in the light absorbing layer, wherein the microspheres provide light
26 tunnels through the light absorbing layer and protrude from the back surface of
the light absorbing layer;

1 (2) providing a second assembly comprising an optically clear highly
conformable layer comprising a first surface or having a front surface and a back
surface, said back surface having a textured finish, a molding layer having a
front surface and a back surface wherein the front surface of the molding layer
has a textured finish and is in contact with the back surface of the conformable
6 layer, and the back surface of the molding layer is in contact with a removable
substrate; (3) laminating the back surface of the microsphere containing layer
of the first assembly to the front surface of the optically clear highly
conformable layer of the second assembly; (4) removing the second removable
substrate and molding layer whereby the conformed layer remains on the
11 microspheres, follows the curved surfaces of the microspheres and is
substantially uniform and the back surface of conformed layer has a textured
finish.

In another method, the light transmitting filter of the invention can be
prepared by the steps of: (1) providing a first construction comprising a molding
16 layer having a front surface and a back surface, a first removable support layer
on the back surface of the molding layer, and an optically clear polymeric layer
on the front surface of the molding layer wherein the optically clear polymeric
layer has a front surface and a back surface, and the back surface is textured,
and wherein the Vicat softening point of the optically clear polymeric layer is
21 greater than the Vicat softening point of the molding layer, (2) providing a
second construction comprising a light absorbing layer having a first surface and
a second surface, and a second removable support layer on the front surface of
the light absorbing layer, (3) heat laminating the front surface of the optically
clear polymeric layer of the first construction to the back surface of the light
26 absorbing layer of the second construction, (4) removing the first removable
support layer and the molding layer from the laminate, whereby the back

1 surface of the conformed layer has a textured finish, provided that either the first construction or the second construction contains transparent microspheres, and the transparent microspheres form light tunnels through the light absorbing layer.

6 The invention may be further understood by reference to the attached figures. Fig. 1a is a cross section of light filter 10. Box 10a is expanded in Fig. 1b to show a conformable coating 11, light absorbing layer 12, transparent microspheres 13 and clear support layer 14. The back surface of the conformed layer 11 has a textured surface 15. Fig. 1c represents another embodiment where conformable coating 11 is attached to tie layer or corona treatment layer 16. The light filter still contains light absorbing layer 12, transparent microspheres 13, a clear support layer 14, and the exposed back surface 15 of the conformed layer 11 has a textured finish.

11 Figs. 2a - 2e illustrate one method for preparing the light filters of the invention. In these figures, the top of each construction is sometimes referred to as the "front" and the bottom is sometimes referred to as the "back" of the construction. Accordingly the surface of each layer closest to the top or front of the construction is referred to as the "upper surface" or the "front surface" and the surface of each layer closest to the bottom or back of the construction is referred to as the "back surface" or the "lower surface". In use, the light enters the filters of the invention from the back surface, and the light is emitted from the front surface.

16 In Fig. 2a, construction 20 comprises a removable support layer 29 (typically paper or a PET film), an optically clear support layer 24, (e.g., a polyacrylate) and a light absorbing layer 25 (e.g., polyvinylbutyral or a thermoplastic polyurethane containing carbon black). Microspheres 26 are embedded in the light absorbing layer 25. A portion of the microspheres is

1 embedded in the light absorbing layer 25 and contacts or perforates the front
surface 25a of light absorbing layer 25. A portion of the microspheres 26
protrudes from the back surface 25b of the light absorbing layer 25. The
construction 20a of Fig. 2b comprises substrate layer 21 (typically paper or a
PET film such as Mylar[®]), molding layer 22 and conformable layer 23. The back
6 (lower) surface 23a of conformable layer 23 has a textured finish. In another
embodiment, molding layer 22 is omitted, and the surface of substrate layer 21
has a textured surface (for example, a release liner with a matte finish on the
release surface) which is transferred to the back surface 23a of layer 23 when
laminated thereto.

11 The construction 20b in Fig. 2c is formed by laminating construction 20
to construction 20a as shown. The lower (back) surface of the light absorbing
layer 25 with protruding microspheres 26 is laminated to the upper surface of
conformable layer 23 whereby the microspheres 26 are forced into the
conformable layer 23, and the material of layer 23 conforms to the shape of the
16 protruding microspheres 26. The molding layer 22 supports the moldable layer
keeping the coating from leveling between the microspheres, and the textured
surface 23a on the back surface of the conformable layer remains substantially
intact. Lamination temperatures and pressures depend on the materials
(polymers) used in the various layers, but, generally, lamination occurs at a
21 temperature of from about 175° (79°C to about 400°F (204°C), or from about
250°F (121°C) to about 350°F (177°C). The lamination pressure is preferably
between about 50 to about 150 psi, or from about 75 to about 125 psi. In
some embodiments the temperature applied to the bottom of layer 21 of
construction 20a is higher than the temperature applied to the top of layer 29
26 of construction 20 when the two constructions are laminated together.

1 After lamination, as shown in Fig. 2c, the conformable layer 23 is now
conformed to the shape of the microspheres 26. Also, the molding layer 22 has
been correspondingly deformed by the entry of the microspheres 26 into the
conformable layer 23. The construction 20c is allowed to cool, and the
microtextured molding layer 22 and support layer 21 are removed as shown in
6 Fig. 2e leaving the laminated construction (light filter) shown in Fig. 2d
comprising removable support layer 29, optically clear support layer 24,
microspheres 26 embedded in light absorbing layer 25 and contacting or
perforating the front surface of the light absorbing layer forming a light
transmitting tunnel through the light absorbing layer 25. The microspheres 26
11 and the light absorbing layer 25 between the microspheres 26 are coated with
a conformed layer of optically clear material 23, and the back surface 23a of the
conformed layer 23 has a textured finish. Removable support layer 29 is
present to provide support during the manufacture and processing of the
construction, and to provide some protection to the optically clear support layer
16 24 from the laminating temperatures. Accordingly support layer 24 is typically
removed before the light filter is used.

Figs. 3a - 3e illustrate another method of preparing the light filters of the
invention. Construction 30 of Fig. 3a comprises a light absorbing layer 35,
clear support layer 36 (e.g., a polyacrylate) and removable support layer 37
21 (e.g., paper or PET film). Construction 30a in Fig. 3b comprises support layer
31, molding layer 32 laminated to layer 33 which is composed of the
conformable materials for the conformed layer. Microspheres 34 are embedded
in the conformable layer 33, and the back surface 33a of conformable layer 33
has a textured surface. Constructions 30 and 30a are brought together, as
26 shown, by laminating under heat and pressure as described above. Fig. 3c
represents the multilayer construction formed when constructions 30 and 30a

1 have been combined. The multilayer construction of Fig. 3b comprises support
layer 31, molding layer 32, conformed layer 33, light absorbing layer 35,
optically clear support layer 36 and removable support layer 37. The
microspheres 34 are now embedded in the light absorbing layer 35 and in the
conformed layer 33. As a result of the lamination process, a portion of the
6 microspheres 34 contact and/or perforate the upper or front surface of the light
absorbing layer thus creating a tunnel through the light absorbing layer 35. The
conformable layer 33 of Fig. 3b is now a conformed layer 33 around a portion
of the microspheres 34. The upper surface of molding layer 32 has been
deformed by the lamination process as shown in Fig. 3c.

11 Fig. 3d illustrates the light filter of the present invention when the support
layer 31 and molding layer 32 are removed from the construction of Fig. 3c as
shown in Fig. 3e. The remaining portion of the construction 30c in Fig. 3d
comprises removable support layer 37, clear support layer 36, light absorbing
layer 35 and conformed layer 33 with the microspheres 34 embedded in the
16 light absorbing layer 35 and coated with the conformed layer 33. The
microspheres 34 contact or perforate the front surface of the light absorbing
layer 35 forming a light transmitting tunnel through the light absorbing layer 35.
The back surface 33a of the conformed layer 33 has a textured finish.
Removable support layer 37 is present to provide support during the
21 manufacture and processing of the construction, and to provide some protection
to the optically clear support layer of polymethyl methacrylate. Thus, the
removable polyethylene terephthalate support layer is removed from the
polymethyl methacrylate layer to provide a light filter with a conformable
coating having a textured (matte) surface on the back (exposed) side of the
26 conformed layer.

1 The following are examples of the preparation of the light filters of the
invention. These examples are illustrative and are not be considered limiting to
the scope of the invention. Unless otherwise indicated in the examples and
elsewhere in the specification and claims, temperatures are in degrees
centigrade, parts and percentages are by weight, and pressure is at or near
6 atmospheric pressure.

Example 1

A 75 micron (3 mil) layer of polyethylene terephthalate (SH-71 Polyester
film from SKC America) is laminated to a 75 micron (3 mil) layer of
polymethylmethacrylate. (Acrylic HI-7 from ICI). A 10 micron (0.4 mil) layer
11 of black polyvinyl butyral (Butvar B-90 from Solutia containing 6% carbon black)
is placed on top of the polymethylmethacrylate. Glass microspheres having a
refractive index of 1.80 and having an average diameter of 52 microns are
embedded into the polyvinylbutyral forming a light tunnel to make construction
1. A paper facestock coated with low density polyethylene and having a matte
16 surface is obtained (e.g., Felix Schoeller Technical Paper F315L), and onto the
layer of polyethylene (matte surface) is coated a 10 micron (0.4 mil) thick layer
of clear polyvinylbutyral (Butvar B-90 from Solutia) to make construction 2.
Construction 1 and 2 are pressed together (black polyvinylbutyral layer with
exposed microspheres of construction 1 to the clear polyvinylbutyral layer of
21 construction 2) at a temperature of 285°F (140°C) and 100 psi using a roll
laminator. The layer of conformable clear polyvinylbutyral conforms around
the protruding microspheres and the polyethylene layer (molding layer having a
lower Vicat softening temperature than the polyvinylbutyral) helps form the
conformable layer to the surface of the microspheres. After cooling, the paper
26 and the low density polyethylene are separated from the other materials to
provide a light filter with a conformable coating having a textured (matte)

1 surface on the back (exposed) side of the conformed layer. The removable polyethylene terephthalate support layer is subsequently removed from the polymethylmethacrylate layer.

Example 2

6 A paper facestock coated with low density polyethylene and having a matte finish such as Felix Schoeller Technical Paper F315L is coated with 0.4 mil (10 microns) of polyvinyl butyral (Butvar B-90), and the glass microspheres of Example 1 are embedded into the polyvinyl butyral layer. A second construction is prepared which comprises a 75 micron (3 mil) layer of polyethylene terephthalate (SH-71 from SKC America) coated with 75 microns (3 mils) of polymethylmethacrylate (MI-7 from Rohm & Haas) and 10 microns (0.4 mil) of black polyvinyl butyral (Butvar B-79 containing 6% carbon black). These two constructions are combined by laminating the exposed layer of black polyvinylbutyral to the layer of clear polyvinylbutyral containing the glass microspheres. Lamination is accomplished at a pressure of about 100 psi and at a temperature of about 285°F (140°C). After cooling, the paper and polyethylene layers are removed thereby exposing the back surface of the conformed layer of clear polyvinyl butyral having a textured finish on the back surface. When the light filter is ready to be used, the polyethylene terephthalate support layer is removed.

Example 3

21 This example illustrates a light filter of the present invention which does not include an optically clear support layer as present in Examples 1 and 2 above. A first construction is prepared comprising a 75 micron layer of polyethylene terephthalate and 10 microns of a black thermoplastic polyurethane P-9827 from Morton containing 6% carbon black. A second construction is prepared which comprises a paper coated with 35 microns of

low density polyethylene having a matte finish on the exposed surface followed by coating with a 10 micron layer of clear polyvinylbutyral. Glass microspheres of Example 1 are then embedded into the polyvinylbutyral. The two constructions are then laminated together by bringing the layer of clear polyvinylbutyral into contact with the layer of black polyurethane whereby the exposed microspheres are embedded in the thermoplastic urethane layer to the extent that the microspheres touch and/or perforate the surface of the black polyurethane layer which is in contact with the polyethylene terephthalate layer thereby forming a light tunnel through the black polyurethane layer. Lamination is accomplished at about 100 psi while maintaining the temperature on the outside of construction 1 (the paper layer) at about 135°C (275°F), and the temperature on the outer layer (polyethylene terephthalate) of construction 2 at about 95°C (203°F). After cooling the laminated structure, the paper and polyethylene layers are removed leaving a conformed layer of clear polyvinylbutyral in contact with the microspheres, and the back surface of the conformed clear polyvinylbutyral has a matte finish. The removable polyethylene terephthalate layer can then be removed to provide a light filter with the desired conformable coating having a textured surface. The light filter of this example may be adhered to a rigid structure, such as a sheet of polycarbonate (Lexan) or polymethyl methacrylate (Plexiglas).

While the invention has been explained in relation to its preferred embodiments, it is to be understood that various modifications thereof will become apparent to those skilled in the art upon reading the specification. Therefore, it is to be understood that the invention disclosed herein is intended to cover such modifications as fall within the scope of the appended claims.